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BENOIST GIRARD SAS
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14201 Hérouville-Saint-Clair Cédex,
France.

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

8098337001

4. Title of the invention

TARGETING APPARATUS FOR USE IN PERFORMING ENDOFEMORAL OSTEOTOMY SURGERY

5. Name of your agent *(if you have one)*

A.J. BRIDGE-BUTLER

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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TARGETING APPARATUS FOR USE IN PERFORMING ENDOFEMORAL OSTEOTOMY SURGERY

This invention relates to targeting apparatus for use in performing endofemoral osteotomy surgery. The apparatus is also suitable for conversion so that it can be used in transfemoral osteotomy surgery. In this particular surgical technique the femur is exposed along a proximal-distal line, the soft tissue (skin, muscle) being folded back on each side to expose the bone. The proximal end of the femur is now opened as a "window" and a femoral prosthesis is inserted into the bone canal.

As mentioned above, the present invention is capable of being used with both surgical approaches if converted.

There are difficulties in both techniques in assessing the particular angular position of the prosthesis in the femoral canal and the exact location of the resectioning of the femur must be accurately judged. A further difficulty arises with regard to the placement of one or more retaining bolts towards the distal end of the stem of the prosthesis. These bolts or pins pass through the bone, the stem of the prosthesis and out through the other side of the bone thus anchoring the prosthesis in position. It is difficult for surgeons to judge the exact position to drill the holes in the bone to coincide with the holes in the implant and it is also necessary to select the correct angular position of the prosthesis and therefore the holes. It is also difficult for the surgeon to judge the exact distance down the femur for the holes to achieve the correct leg length of the correction.

The present invention is intended to overcome some of the difficulties referred to above and to provide apparatus which will achieve a more accurate surgical technique.

According to the present invention targeting apparatus for use in performing endofemoral osteotomy surgery comprises a support element provided with a drill guide, means for securing the support element to the proximal end of the prosthesis to be implanted and which include a proximal location element which is shaped to extend around the great trochanter and muscles of the femur in which the implant is to be located, and means for adjusting the angular position of the drill guide in relation to the femur about a proximal-distal axis.

Thus, the apparatus can be used to accurately locate the angular position of the drill guide and the prosthesis (anteversion setting) and which can be used to drill the holes to take the retaining bolt or bolts in the bone.

Preferably the proximal location element is in the form of a curved arm connected to the support element and this arm can be substantially S-shaped.

The proximal location element can be arranged to be detachable from the support element, for example, by means of a plug and socket connection, and this can be of a triangular cross-section.

Two detachable alternative proximal location elements can be provided, one for use with a right femur and the other for use with a left femur.

The targeting apparatus according to the invention can also be used for performing transfemoral osteotomy surgery by the provision of suitable conversion features. Thus, the apparatus can include conversion means for converting it for use in performing transfemoral osteotomy surgery.

The conversion means can include means for securing the support element to a resectioned femur to allow this form of surgery to be carried out.

Alternative means are also provided for securing the support element to the prosthesis to be implanted and which is adapted to replace the shaped proximal location element.

This alternative means may comprise a substantially straight proximal arm adapted for connection to the support element.

When converted in this way the apparatus can embody the features set forth in British Patent Applications Nos. 00 27698.0 of 13 November 2000, 00 27700.4 of 13 November 2000 and 01 05779.3 of 8 March 2001.

The invention can be performed in various ways and some embodiments will now be described by way of example and with reference to the accompanying drawings in which :

Figure 1 is an isometric view from above showing the layout of the targeting device according to the present invention when set up for use in performing endofemoral osteotomy surgery;

Figure 2 is an isometric view from a first side of part of the apparatus shown in Figure 1;

Figure 3 is an isometric view of part of the apparatus from the other side;

Figure 4 is a diagrammatic side view of a femur showing how it is cut for performing transfemoral osteotomy surgery;

Figure 5 is a diagrammatic perspective view showing how the "window" is formed in the femur for transfemoral osteotomy surgery;

Figure 6 is an isometric view from above of the apparatus shown in Figure 1 when converted for use when performing transfemoral osteotomy surgery and in position on the femur;

Figure 7 is an isometric view from above showing part of the apparatus shown in Figure 6 with the proximal location element detached;

figure 8 is a part cross-sectional view of means for securing the support element of the apparatus shown in the preceding Figures to a prosthesis to be implanted;

Figure 9 is a side elevation of a clamp device shown in Figure 6 for securing the support element to a resectioned femur;

Figure 10 is a front elevation of the clamp device shown in Figure 9;

Figure 11 is an isometric view of part of the support element;

Figure 12 is a partial side view of an alternative construction of the clamp device shown in Figures 9 and 10;

Figure 13 is an isometric view of the construction shown in Figure 12;

Figure 14 is an isometric view of the construction shown in Figure 13 partially dissembled;

Figure 15 is an end view of the device shown in Figure 11 incorporating the alternative constructions shown in Figures 12, 13 and 14 and including visual indicator guides with the support element in a first position;

Figure 16 is a similar view to Figure 15 with the support element in a second aligned position;

Figure 17 is an isometric view showing a drill guide which can be clamped into position to enable holes to be made through the bone and soft tissue when it has been folded back into a position on the femur;

Figure 18 is a front elevation of the clamp as shown in Figure 10 attached to a drill guide element;

Figure 19 is a plan view from above of the drill guide element shown in Figure 18 in part cross-section on the line V-V of Figure 19;

Figure 20 is an end view of the drill guide element shown in Figure 1.

In endofemoral osteotomy surgery the proximal end of the femur is resectioned by removing the proximal end of the femur. The stem of the prosthetic implant is inserted into the proximal end of the bone canal and accurately located by the surgeon. The exact position of the femur must be accurately judged and the distal end of the stem of the implant usually carries one or more openings through which one or more retaining bolts are passed. Thus these bolts pass through the bone and the implant to anchor the stem of the prosthesis.

It is difficult for surgeons to judge the exact position to drill the holes so as to coincide with the holes in the implant and to select the correct angular position. The position of the holes also controls the corrected leg length.

Figure 1 shows a targeting apparatus for use in performing endofemoral osteotomy surgery and this comprises a support element 1 provided with two drill guides 2 and means 3 for securing the support element 1 to a prosthesis 4 which is to be implanted in a resectioned femur which is indicated by reference numeral 6. Adjustment means 7 are

included for adjusting the angular position of the drill guides 2 in relation to the resectioned femur 6 about a proximal-distal axis.

The support element 1 is in the form of an L-shaped frame which has a first arm 10 and a second proximal location element provided by a curved arm 11. As will be seen from Figures 1, 2 and 3 the curved arm 11 is substantially S-shaped. Thus the first arm 10 carries the drill guides 2 and the proximal location element provided by the S-shaped arm 11 carries the means 3 for connecting the support 1 to the proximal end of the femoral prosthesis.

The means 3 for connecting the support element 1 to the femoral prosthesis through the proximal location element provided by the S-shaped arm 11 is shown in more detail in Figure 8 and comprises a sleeve 20 secured to the S-shaped arm 11 and in which is located a securing stud 21.

The proximal end 22 of the prosthesis 4 is provided with a screw threaded bore 23 in which a screw threaded portion 24 of the stud 21 can be located. The other end of the stud is held by a nut 25.

The distal end of the sleeve 20 is provided with a pair of opposed projecting keys 26 which engage in keyways 27 in the form of slots provided in an enlarged end portion of the bore 23.

Thus, it will be seen that the prosthesis 4 can be held in position on the S-shaped arm 11 and be restrained against relative rotation by the keys 26 and the keyways 27.

The drill guides 2 are carried on the arm 10 by a clamping plate 40 which is held in place by a screw threaded shaft 41 which engages a screw thread 42 in the clamping plate. The screw threaded shaft 41 passes through a series of openings 43 in the arm 1. As will be seen from the drawings, once the guides have been fixed in position there is a predetermined distance from the guides to the means 3 for connecting the support element 1 to the femoral prosthesis 4. This distance can however be adjusted by using the alternative openings 43. The drill guides 2 are set for a position with respect to the given prosthesis so that they are fixed and aligned with the holes (not shown) in the prosthesis 4.

A typical drill bit 45 is shown in place in one of the drill guides 2 and its lower operative end 46 (as shown in Figure 2) indicate how it has been drilled through the femur 6 passing through the existing holes in the stem of the prosthesis and through the other side of the femur 6.

The proximal location element in the form of the S-shaped arm 11 is detachable from the support element 1 and is secured by a plug and socket connection indicated by reference numeral 90. A triangular socket 91 is provided in the arm 10 into which a triangular shaped plug 92 is inserted. This construction is more clearly shown in Figure 7.

The plug 92 is retained in position by a locking screw 93 in the end of the arm.

The proximal location element in the form of the S-shaped arm 11 is shaped to extend around the great trochanter and muscles (indicated by reference numeral 94 in Figures 1 to 3) of the femur in which the implant is to be located. This enables a frame of the type described above to be employed.

Two S-shaped arms 11 are provided, one for use with a right femur and the other for use with a left femur, the appropriate arm being used.

To carry out the surgery relating to endofemoral osteotomy the surgeon first ensures that appropriate X-rays have been taken so that he can consider the amount of bone which needs to be removed from the femur. Once this has been decided the measurements are carefully taken for further use with the apparatus according to the invention.

The femur is appropriately resectioned and the prosthesis is inserted. It is then connected to the targeting device by means of the means 3 for connecting it to the support element 1. With the support element 1 now suitably connected it is rotated axially about a proximal-distal axis of the femur until the correct position of the drill guides 2 is achieved. They will have been previously set to an appropriate and predetermined position on the proximal-distal axis. A visual indicator guide arm 70 is attached to the L-shaped frame in the form of a rod and this can also be employed to achieve the correct position. With the targeting device accurately located the surgeon can drill the required holes in the femur 6 and this can be done without interfering with the muscles 94.

The targeting apparatus shown in Figures 1 to 3 can also be employed for performing transfemoral osteotomy surgery by adding additional components.

In this surgical technique the femur is exposed along a proximal-distal line, the soft tissue (skin, muscle) being folded back on each side to expose the bone. The proximal end of the femur is now opened as a "window" and a femoral prosthesis is inserted into the bone canal.

Figures 4 and 5 show, in simplified form, how transfemoral osteotomy surgery is performed. The soft tissue indicated by reference letter T in Figure 5 is exposed along a proximal/distal line indicated by chain line L in Figure 5. The soft tissue T is folded back on each side to expose the femur 6 and the bone is resected with three cuts along the same line L two side cuts M and with a transverse cut C. The proximal end of the femur is now opened, as shown in Figure 5, as a "window". From Figure 5 it will be seen that an upper quarter 48 is now laid on each side of the remaining part of the bone to expose the bone canal into which the prosthesis is to be inserted.

Figures 6 and 7 show how additional or substituted parts are used with the targeting apparatus as shown in Figures 1 to 3 so that it can be converted for use in performing transfemoral osteotomy surgery. The same reference numerals are used to indicate similar parts as in Figures 1 to 3.

In Figures 6 and 7 the same reference are used to indicated similar parts to those shown in Figures 1 to 3 but the S-shaped arm 11 is substituted by a substantially straight proximal arm 11a which is provided with the same type of plug and socket 50 and connecting means 3. Additionally femur securing means 5 are provided which are connected to the first arm 10 by an adjustable bracket 12 which can be adjusted in proximal-distal directions only in a slot 13 in the arm 10 and locked in position by a retaining nut 14, and the femur securing means 5 can be angularly adjusted in relation to the bracket 12 in a slot 15 provided on the bracket and locked in position by a nut 16. The nut 16 is carried on a screw threaded boss indicated by reference numeral 17 is carried on the femur securing means 5.

The means 5 for securing the support element to a resectioned femur 6 is most clearly shown in Figures 9 and 10 and comprises an open-jawed clamp device. This device has a main body portion 30 on which is located a movable clamping jaw 31. The upper part of the clamping jaw 31 has a screw threaded bore 32 which houses a threaded member 33 one end of which carries an operating handle 34 and the other end of which is rotatably housed in the body 30. Thus, rotation of the handle 34 raises and lowers the clamp 31 which is also located by a retaining screw 35 which passes through a slot 136.

The lower end of the open jawed clamp is formed as a pair of curved tines 36 which are adapted to extend around the resectioned femur to which the device is to be clamped.

Guide means in the form of a disc 38 mounted on body 30 are provided, the disc projecting below the lower end 39 of the body 30.

The boss 17 is located in a slot 40 in the body 30 and held by a nut 37 but is free to move so that the position of the clamp adjusts itself in relation to the adjustment bracket 12 to alter the radial distance from the femur 6.

In order to clarify the drawings in Figure 6 the soft tissue T and bone which has been folded back to provide the "window" and expose the femur 6 is not shown but the femur will be in the condition shown in Figure 5.

To carry out the surgery relating to a transfemoral osteotomy the surgeon first ensures that appropriate X-rays have been taken so that he can consider the amount of bone which needs to be removed from the femur. Once having

decided this the measurements are carefully taken for further use with the apparatus according to the invention.

The "window" is now opened to reveal the femur and the bone is cut appropriately to provide a proximal end C, indicated by reference numeral 49 in Figure 5. The clamp 5 is now located in position on the end of the femur by tucking it around the femoral end and ensuring that the guide disc 38 is close up against the severed end 49. The positioning is achieved with a rotative movement. Once in place the handle 34 is operated to close the clamp and retain it in place. The stem (not shown) of the prosthesis 4 is now inserted in the femoral canal and the frame in the form of the arms 10 and 11 is connected to it by means of the securing means 3.

The nut 14 is released to allow the bracket 12 to move in the slot 13 and so that it can be secured to the femur securing means 5 by the boss 17 and nut 16 through the slot 15. The release of the nut 16 allows the slot 15 to be placed on the boss 17 at the appropriate radial distance from the femur prior to subsequent tightening. It will be appreciated that the proximal-distal movement in the slot 13 accommodates the leg length adjustment. The ante/retroversion adjustment is now carried out by revolving the frame about the axis of the prosthesis 4 and the particular angle adjustment is set by tightening the nut 16. During this angular movement the prosthesis 4 which is securely attached to the support frame revolves with it as do the drill guides 2.

The proximal-distal positioning of the drill guides is set according to the pre-operative planning and they are now positioned by releasing the nut 42 so that they can be located in contact with the cortex of the femur and the nut suitably tightened.

The drill guides can now be used to produce the necessary holes through the bone to accept the required bolts or pins.

In the arrangement described above two drill guides are shown but only one or any other number can be utilised if required.

The apparatus can be simply removed by releasing the stud 21 in the prosthesis 4, releasing the nut 16 and removing the frame. The clamp 6 can be removed separately.

The "window" is now closed according to any known post-operative technique.

Figure 11 shows an alternative construction in which the same reference numerals are used to indicate similar parts. In this arrangement the adjustable bracket 12 can be readily disconnected from the first arm 10 of the L-shaped frame. In this construction the nut 14 is shown as a hand nut and is carried on a boss 50 which has a bore 51 adapted to receive a spigot 52 provided on the end of the bracket 12. The boss 50 also carries a screw threaded locking nut 53 which can be advanced through a screw threaded bore (not shown) so that it engages against the spigot 52 where it is located in the bore 51 to clamp it in position. This construction enables disconnection of the assembly without having to unscrew the locking nut 14 thus enabling the leg length to be set without readjustment.

Figure 12, 13 and 14 show an alternative construction for the open jawed clamp device and the same reference numerals are used to indicate similar parts to those shown in Figures 9 and 10. In this construction however, the boss 17 is replaced by a bolt 60 which extends

Using the visual indicator guides the apparatus is placed in position with the clamp positioned perpendicular to the 90° knee flexion plane. This is the first position of the anteversion at 0° and this is shown in Figure 15. In Figure 16 the L-shaped frame 10 has been rotated until the visual indicator guides 70, 71 are parallel. In this position the frame 10 has been rotated through 15° in relation to the clamp 30. Thus, the neck axis is parallel to the axis of the frame 10 and the rotation of the frame has thus created an angle between the clamp and the frame which is the anteversion angle. The exact angle of anteversion can be read from a scale indicated by reference numeral 72 provided on the bracket 12.

The standard value of anteversion is 15° and this can be used as a datum when setting up the apparatus.

When the "window" is closed it is necessary to fold the soft tissue and bone which has previously been folded back to provide the window back into position and locate it around the installed prosthesis. Figure 17 shows how a proximal drill guide 75 can be provided to guide drills through the folded back "flap" and to enable the drills to line up with pre-arranged holes 76 provided on the prosthesis 4. This device is in the form of an open jawed clamping block 77 which is provided with a tightening screw 78 which passes through a threaded bore (not shown) in the block to extend into the gap 79 provided between a lower clamping jaw 80 and an upper clamping jaw 81. The clamping block 77 carries an arm 82 which supports a pair of drill guides 83.

As will be seen from Figure 17 the prosthesis is provided with a series of openings 76. With the prosthesis in position in the support element 1 and held by the second arm 11 the clamping block is placed in position and the

drill guides are aligned by the use of guide rods or drills 84. With the drill guides now aligned with the openings 76 the clamping screw 78 is tightened to lock the clamping block in position. The rods or drills 84 can now be removed, the "window" is closed and the drill guides employed to guide the drill or drills to make openings in the flap of bone and soft tissue 48. The openings can then be located by passing wire hoops through the openings and suitably locating them thus ensuring that the flap of material is held in place.

Figures 18, 19 and 20 show apparatus for carrying out the first part of transfemoral osteotomy surgery as shown in Figures 1 and 2 and utilises the clamp device shown in Figures 9 and 10 for securing the support element to a resectioned femur. The apparatus includes a drill guide element 100 which is secured to the femur 6 by the open jawed clamp device which has a boss 17 located in a slot 40 in the body 30 and is held by nut 37 so that the position of the drill guide element 100 can be adjusted to alter the radial distance from the femur 6.

The drill guide element 100 comprises a semi-circular support 101 connected to a location bracket 102. This bracket 102 has a slot 103 through which the end of the boss 17 can extend, the bracket being held in position by the nut 16.

The surface of the bracket 102 is carried with graduations 104 to indicate the relative angular position between the two parts.

The drill guide element 100 includes a line of drill openings 106 along each side and which are adapted to guide a drill, the line of openings extending in a proximal/distal direction. Two parallel lines of drill openings are provided.

Adjacent drill openings 106 are angled in relation to each other and as will be seen from Figure 19 each of the entry points 107 on the outer side of the element serves three openings on the inner side of the element so that there are more entry points or openings on the inner side of the element than there are on the outer side. This enables a row of closely spaced openings to be drilled on each side.

Means for guiding means for exposing the femur along a proximal/distal line are also provided in the form of a guide slot 110 through which the surgeon can open soft tissue and subsequently saw the first longitudinally extending cut in the bone 6 after it has been previously transversely cut.

The apparatus is used for resectioning a femur when performing transfemoral osteotomy in the following manner. The surgeon first makes a transverse cut C to expose a proximal end of the femur which can be used as a reference point. This reference point end is exposed by the surgeon and the means for securing the drill guide element to the femur, that is the clamp, is placed in position by sliding the tines 36 around the bone ensuring that the guide disc 38 is close up against the severed end indicated by reference numeral 49. As mentioned above, the positioning is achieved with a rotative movement. Once in place the handle 34 is operated to close the clamp and maintain it in place. The drill guide element 100 is now placed and locked in position by nut 16. The element extends over the femur and the surgeon now opens the upper part of the femur by severing the soft tissue through the slot 101. This exposes the femur beneath it so that the surgeon can cut a proximal/laterally extending slot. The surgeon now drills a series of holes using the drill guide means through the soft tissue and into the bone. The row of holes in the

bone provides a row of perforations which can be easily broken away to provide the side cuts M but leaving the two broken away parts of the bone still attached to the remainder by the soft tissue in the manner shown in Figure 5.

The "window" now obtained can be used for the remainder of the operation and leaves the femur ready to receive the prosthesis.

Prior to opening the bone the drill guide element 100 will, of course, have been removed by releasing the nut 16 but the securing means in the form of the clamp can be left in position. The same clamp is now used during the remainder of the operation to act as means for securing a support element provided with a drill guide to a prosthesis to be implanted and to a resectioned femur, and means for adjusting the angular position of the drill guide in relation to the resectioned femur about a proximal/distal axis as explained above.

The drill guide element can be used with the clamp in place on the targeting apparatus but if desired it can be removed and used separately with the drill guide element 100 as described above.

The targeting apparatus according to the invention provides a modular construction which includes a support element with a drill guide, means for securing it to a prosthesis, alternative means for securing it to the prosthesis, means for securing it to the femur, a drill guide for drilling holes in the proximal end of the prosthesis and a drill guide for drilling a line of openings in the proximal-distal direction when preparing the "window" when performing transfemoral osteotomy surgery. The modular construction allows the various parts to be assembled together as

required. Alternatively only some of the apparatus is required when performing endofemoral osteotomy surgery. When supplied as a complete kit the various parts can be assembled together as required at the time.

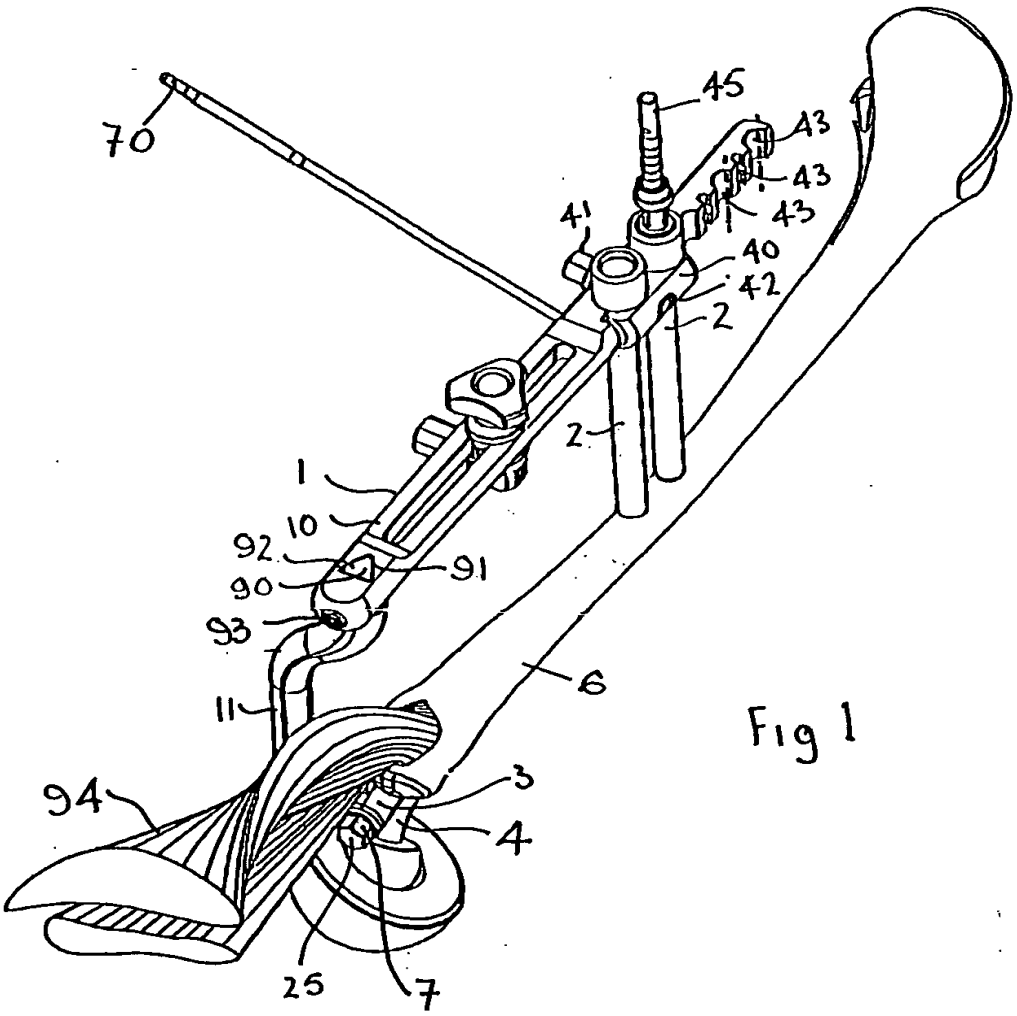


Fig 1

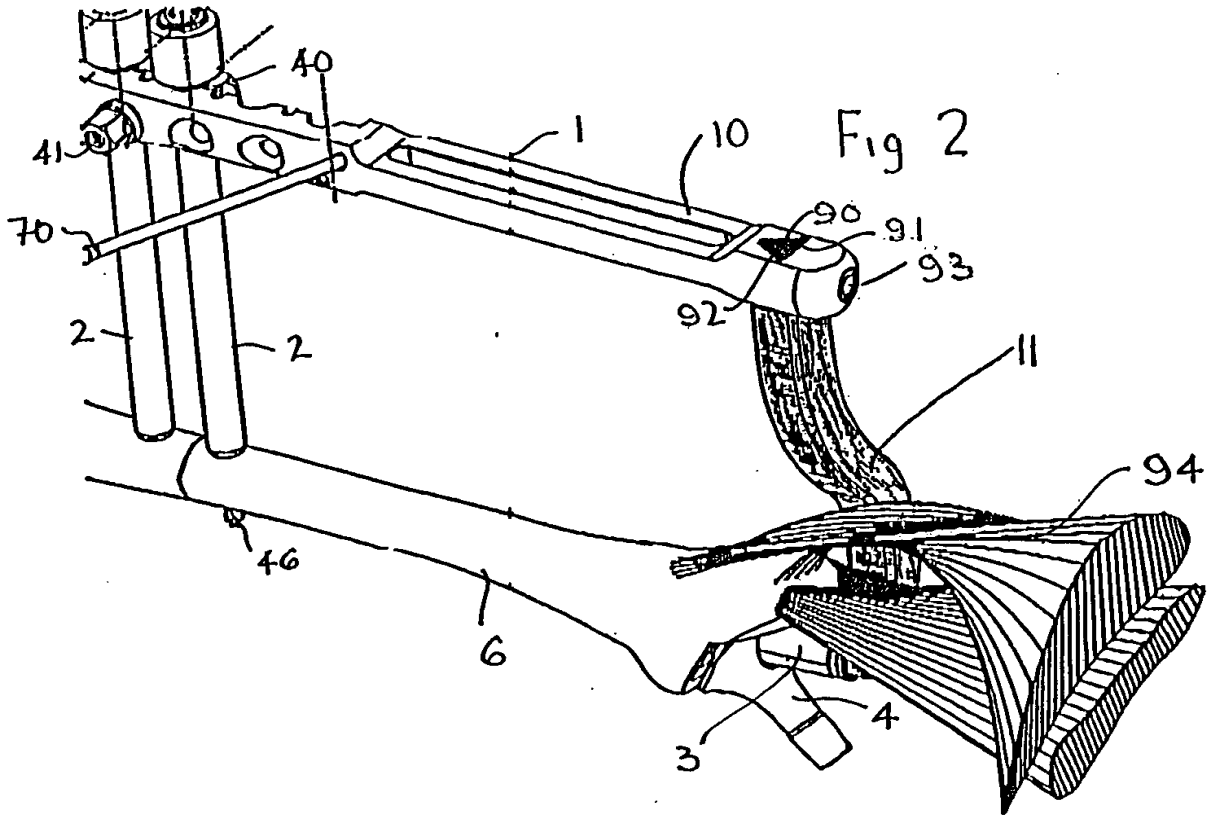


Fig 2

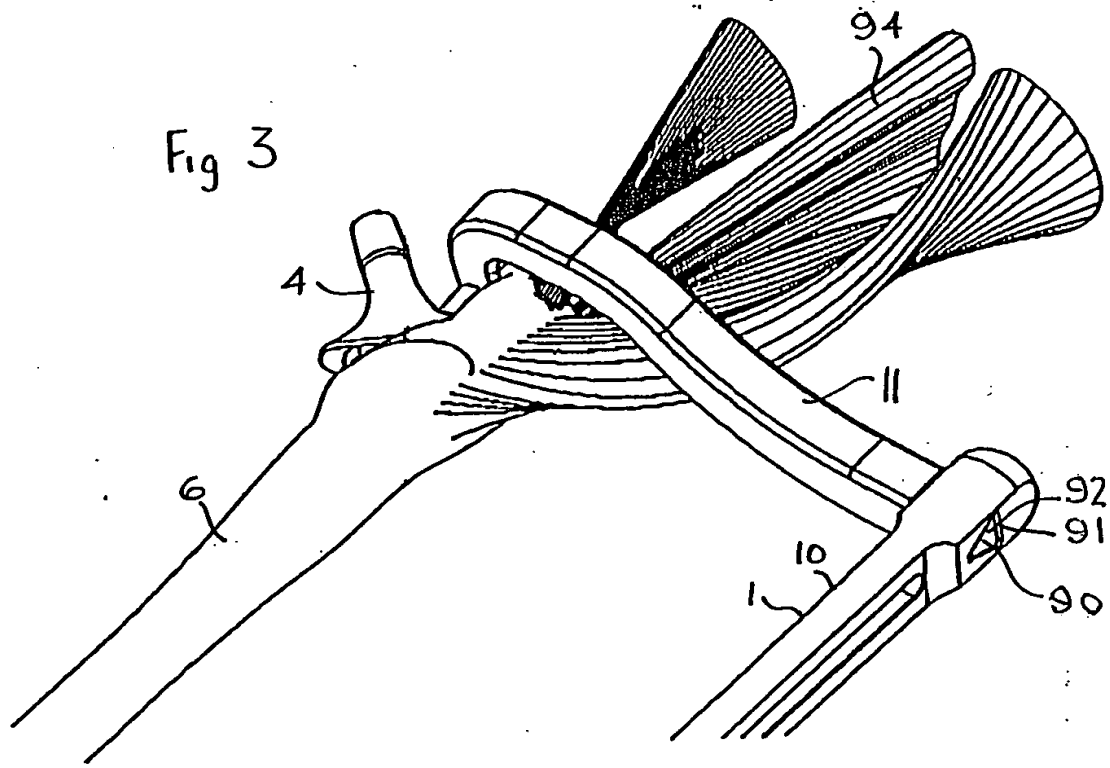
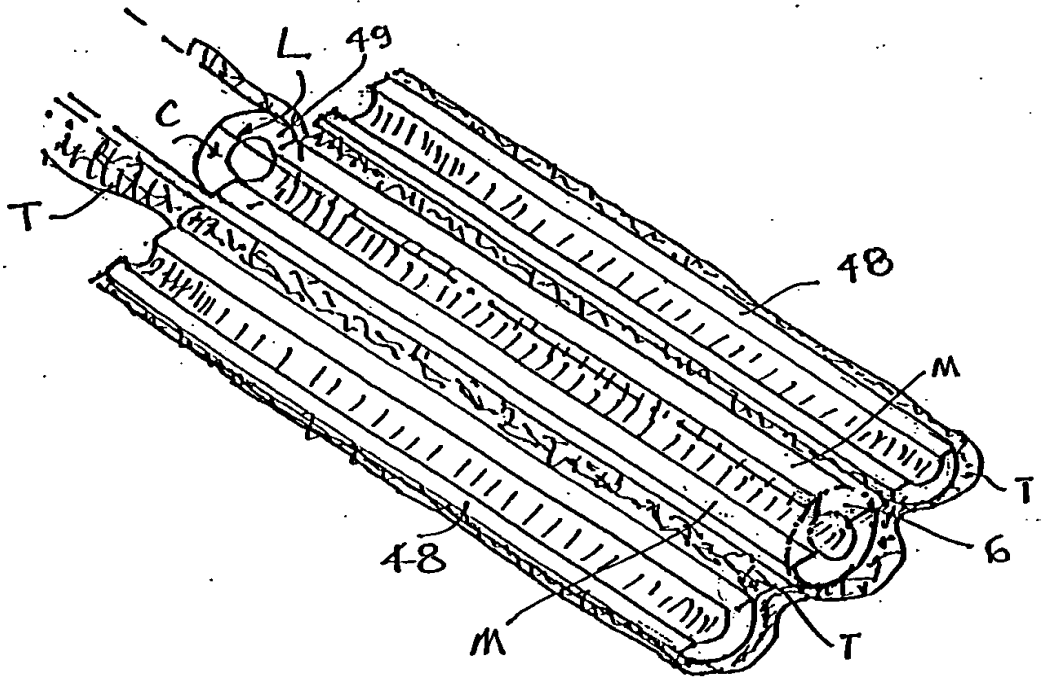


Fig 3

Fig 5



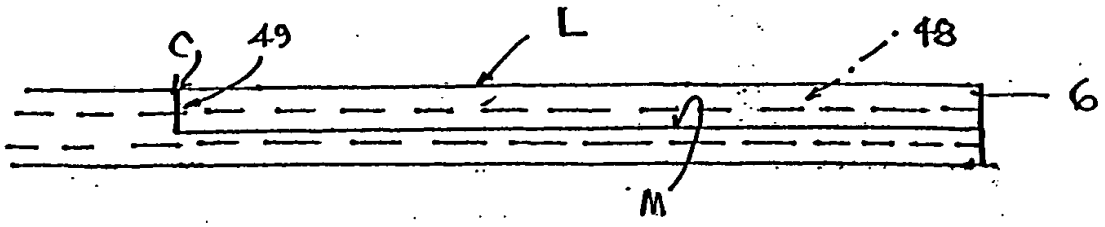
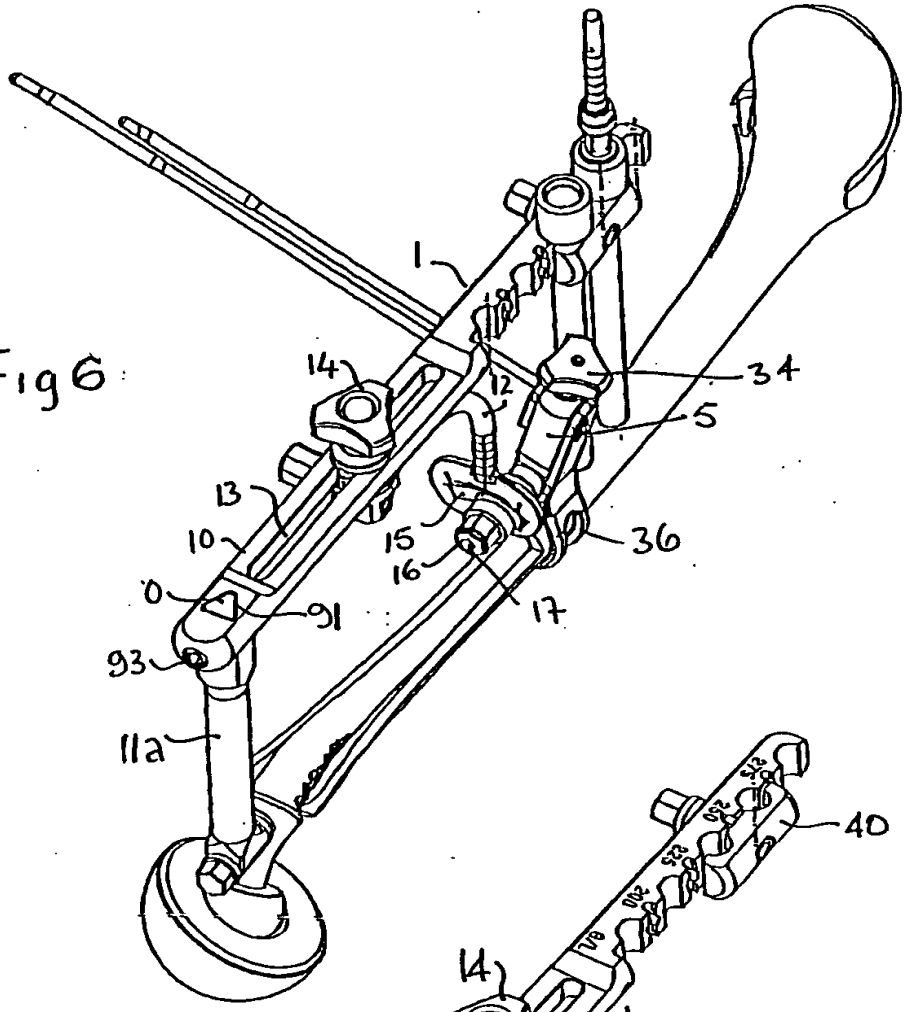


Fig 4

Fig 6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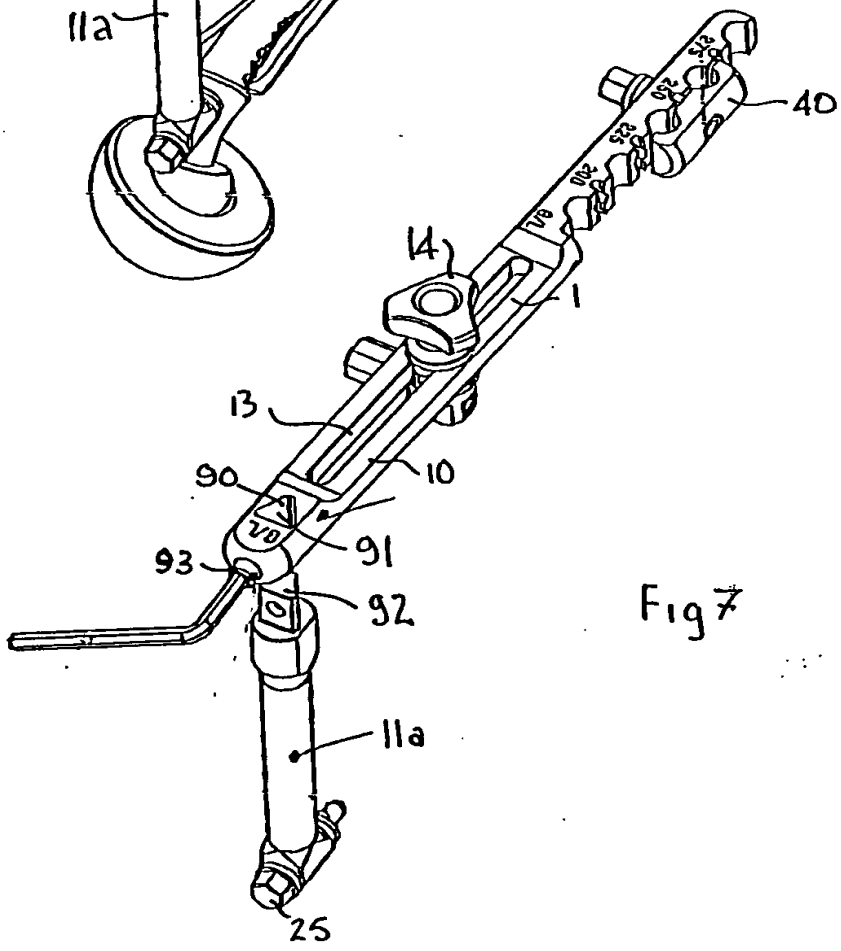
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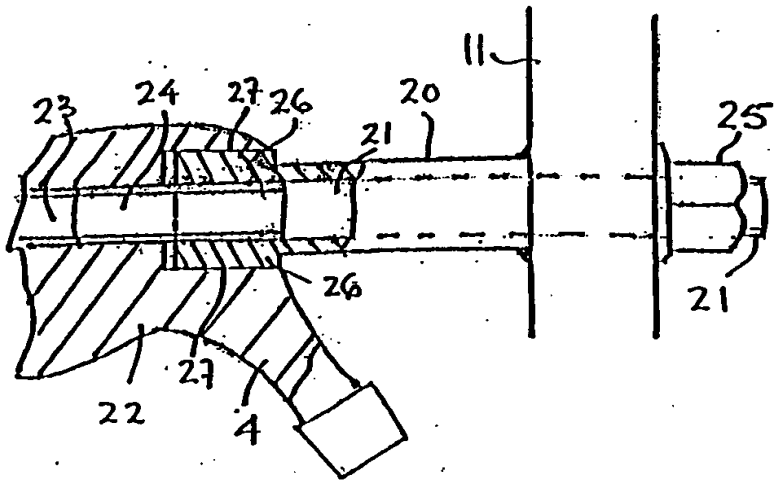
1
13
10
90
V0
91
93
92
11a
25

Fig 7

Fig 8.



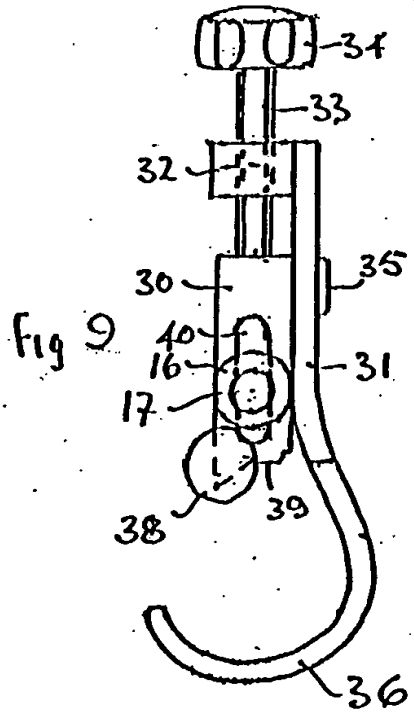


Fig 9

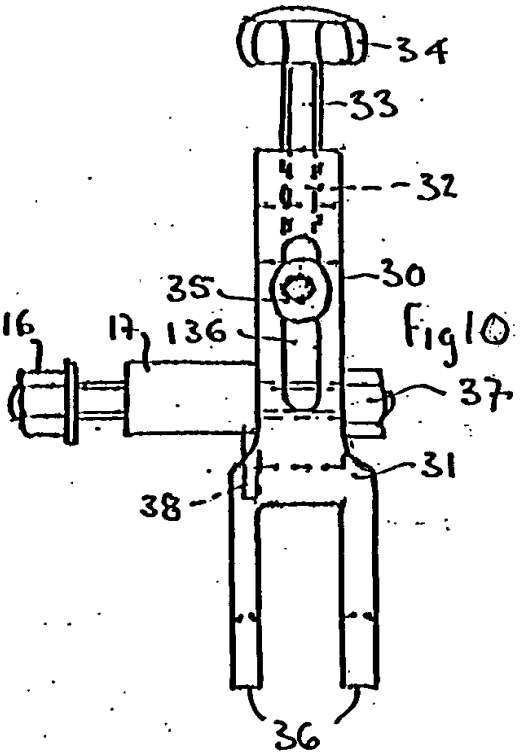


Fig 10

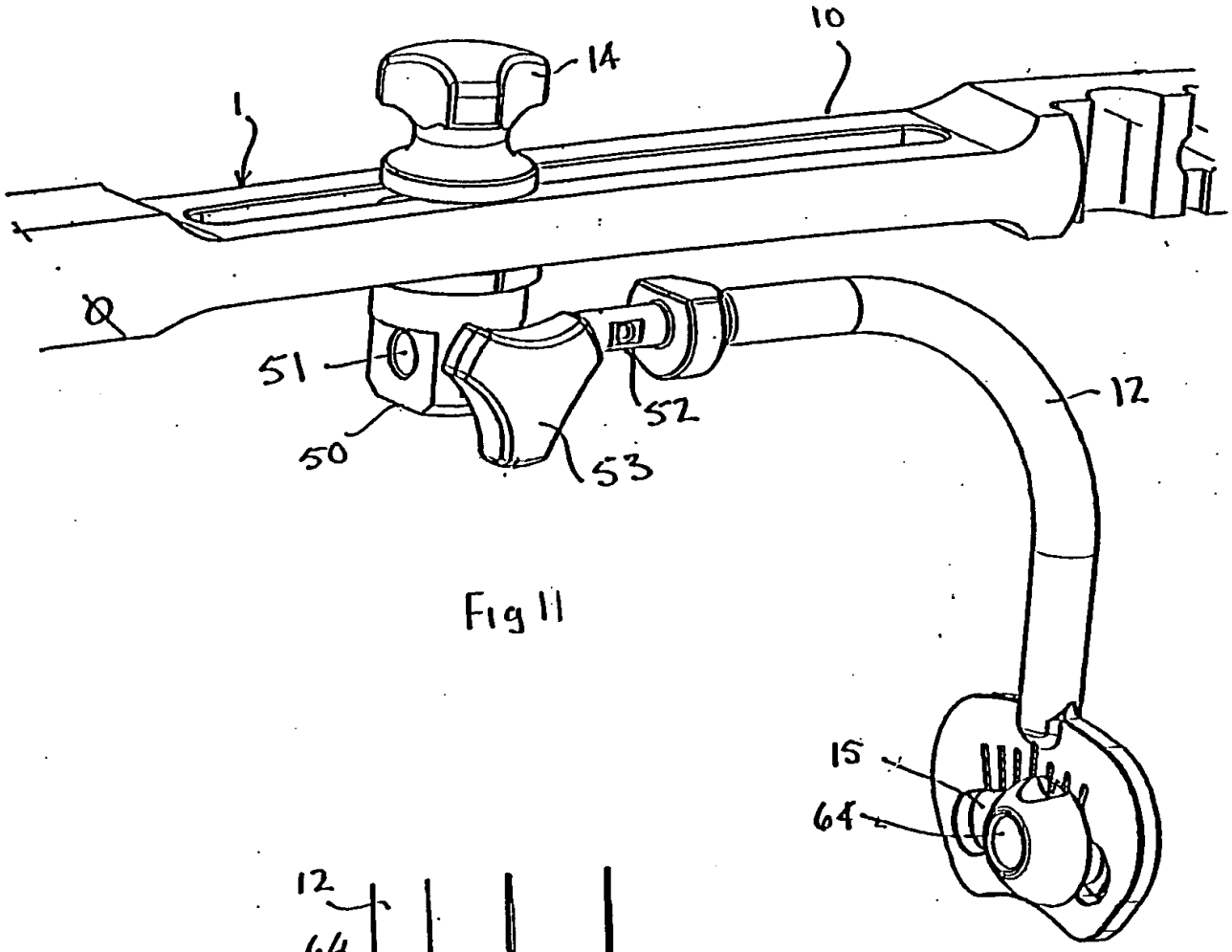


Fig 11

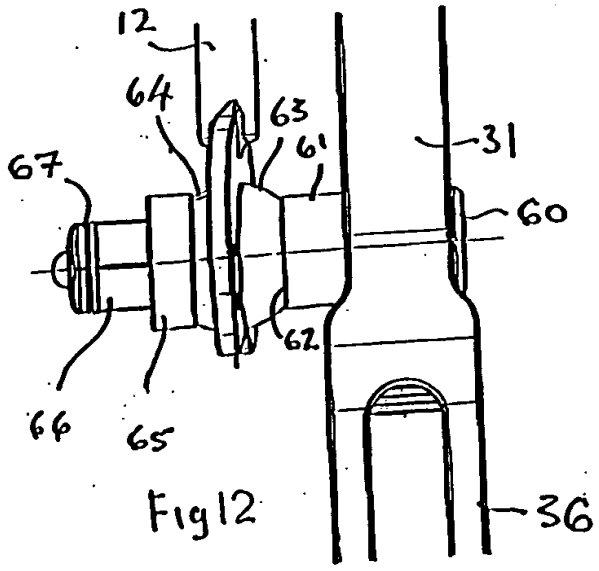


Fig 12

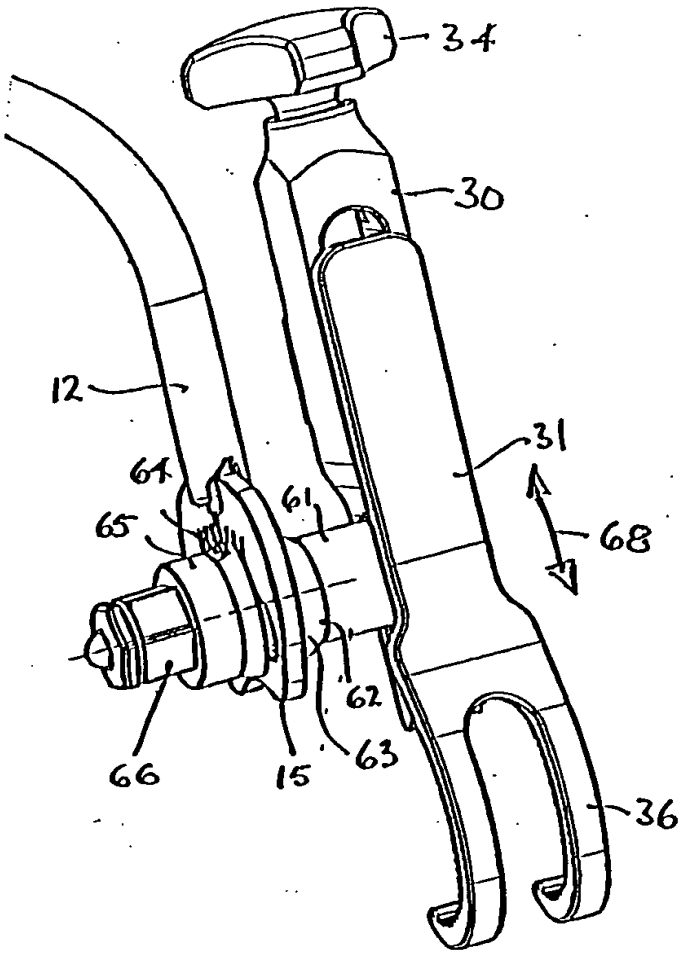


Fig13

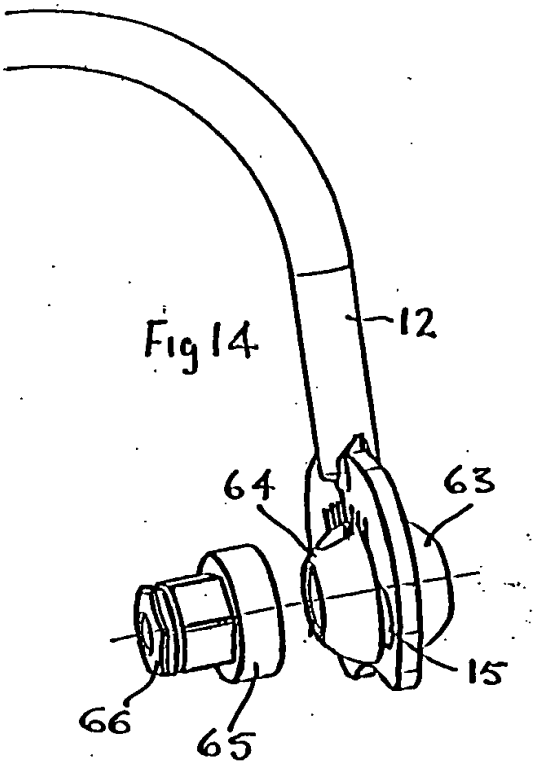


Fig14

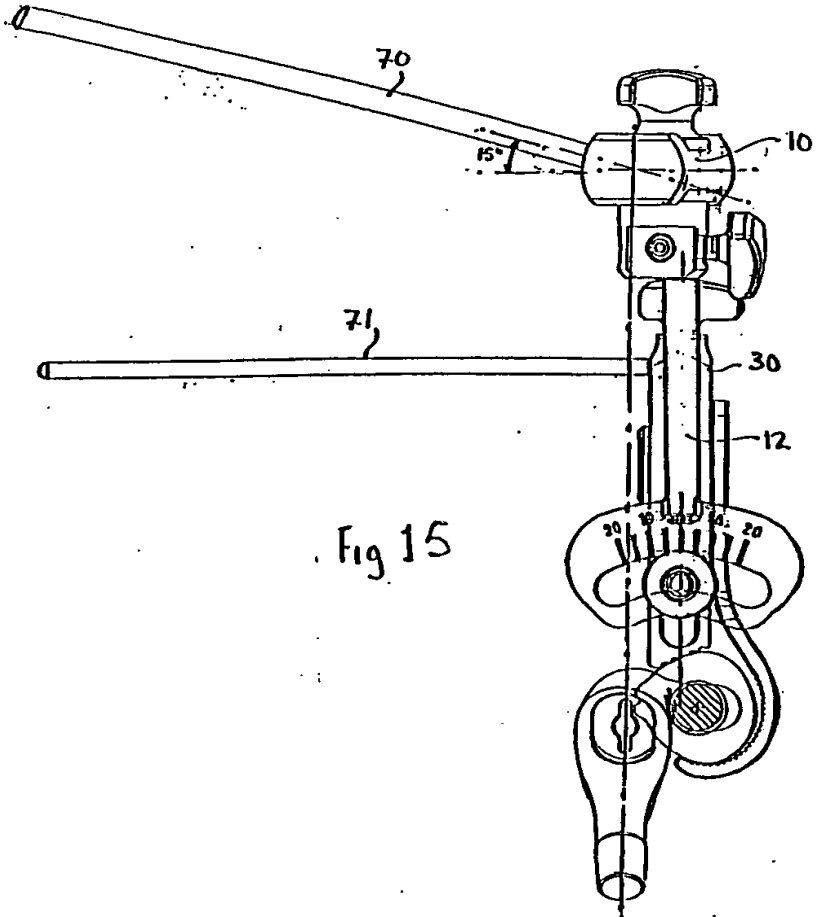


Fig 15

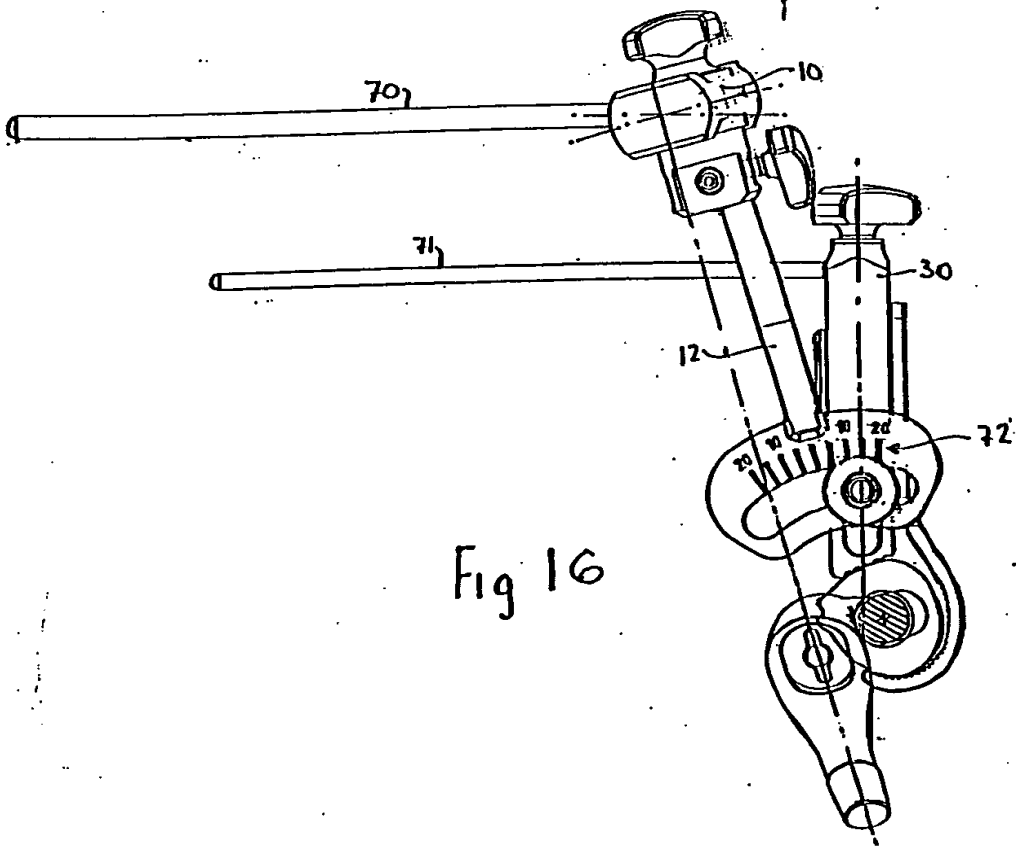


Fig 16

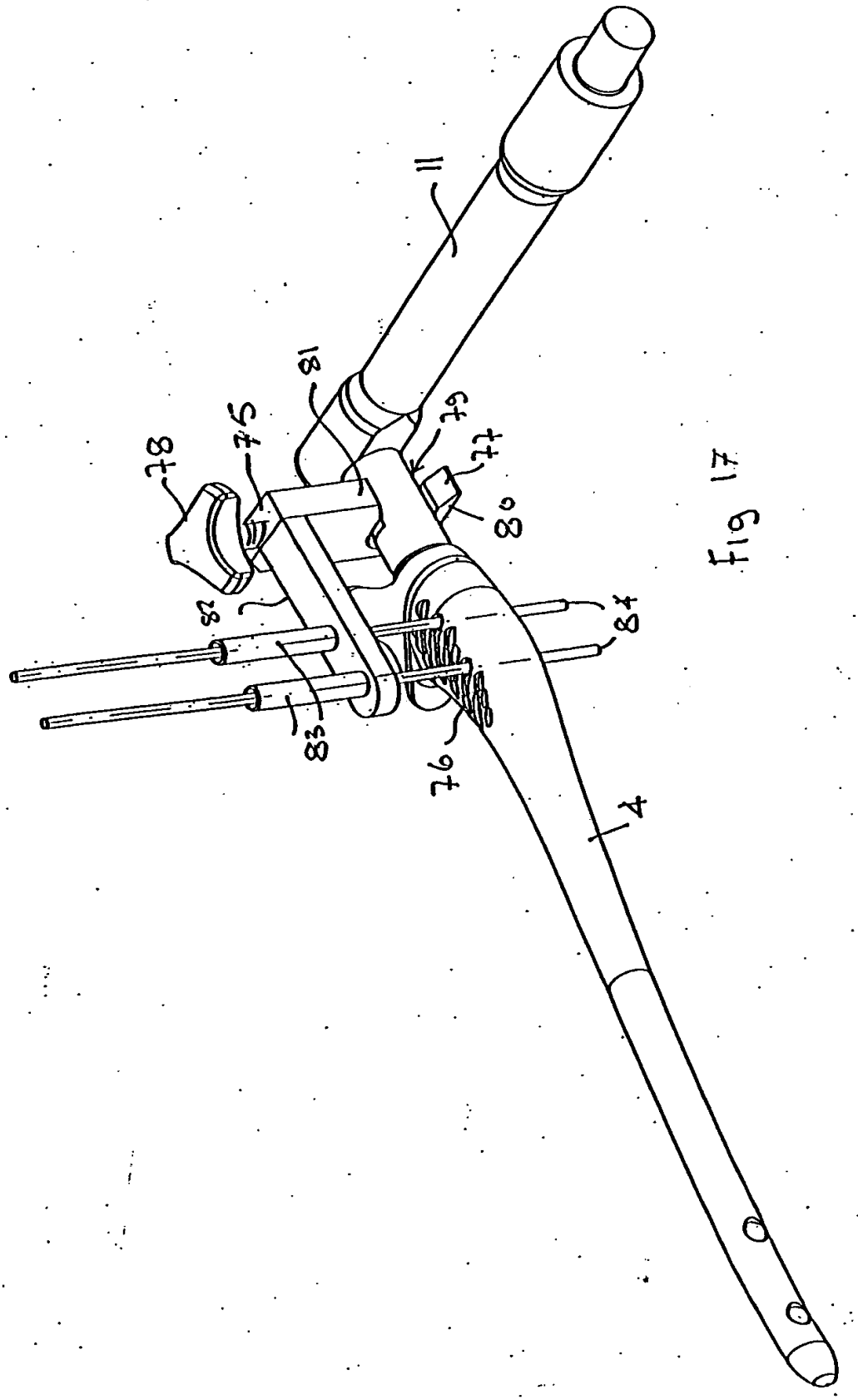


Fig 17

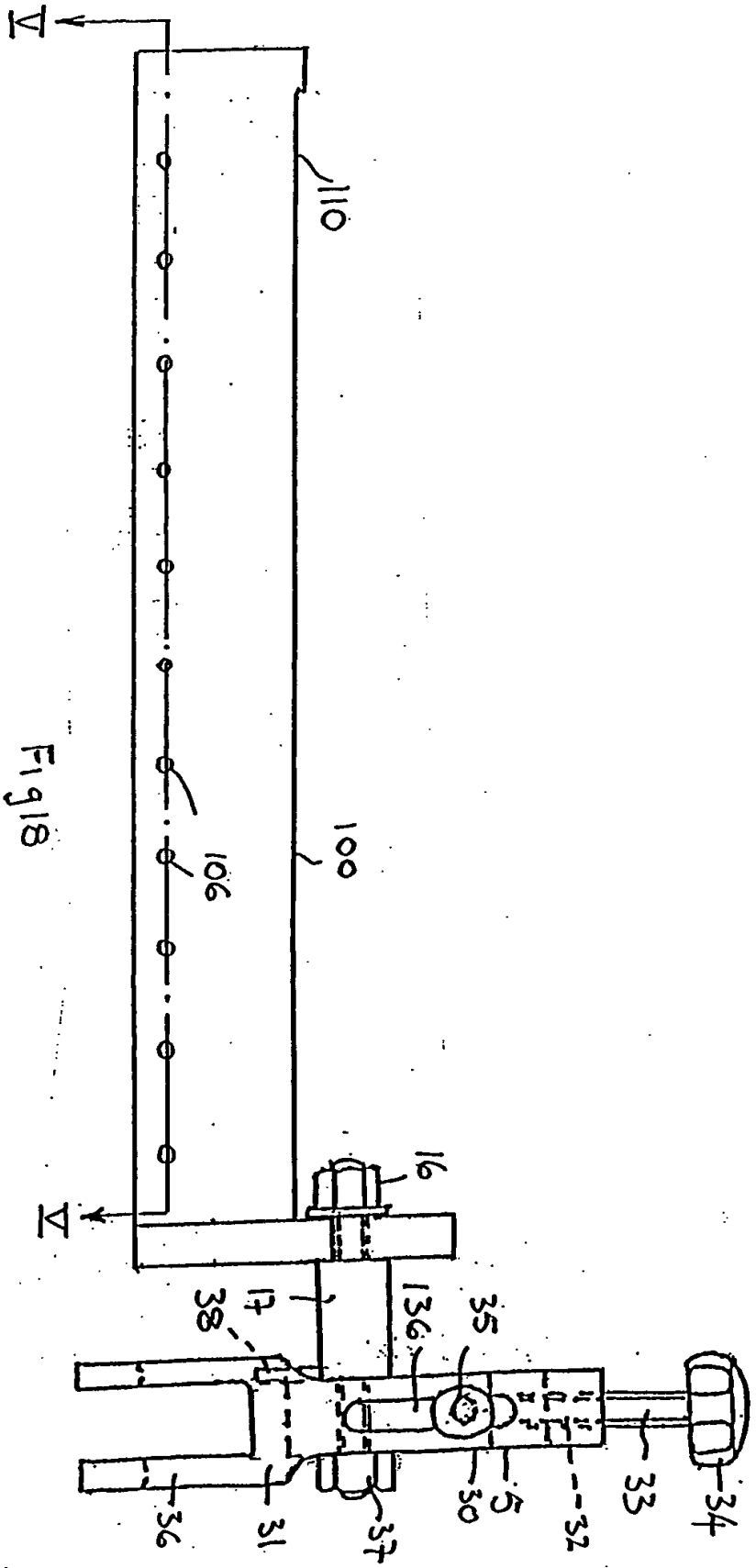


Fig 18

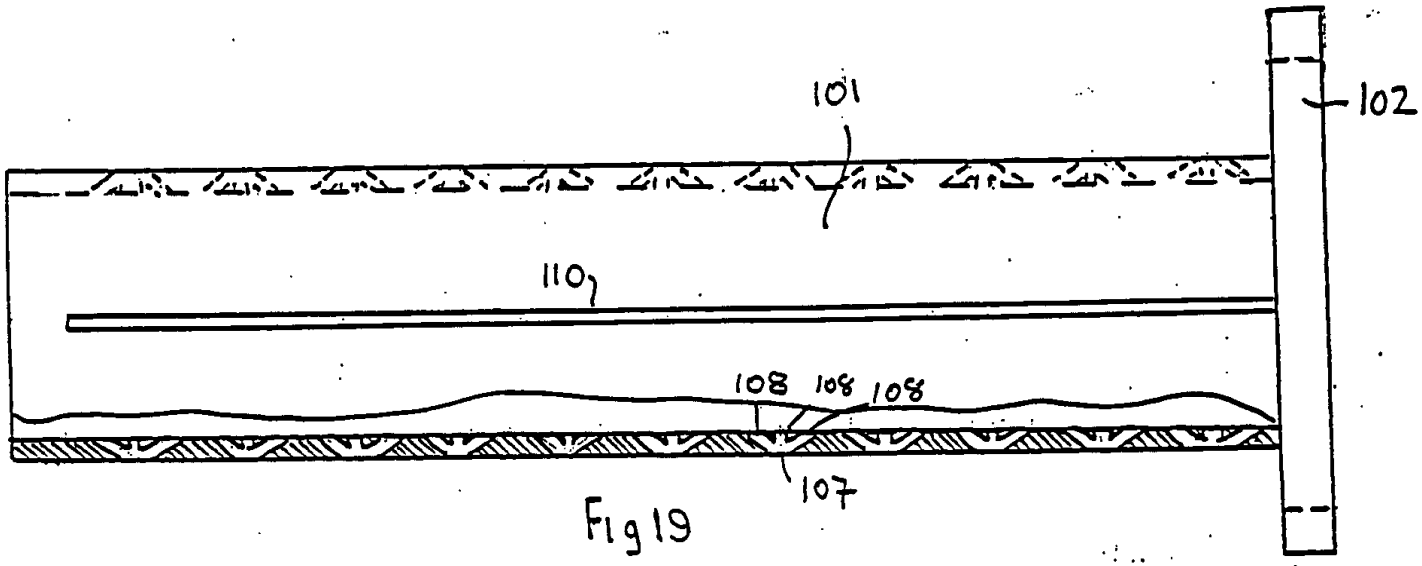


Fig 19

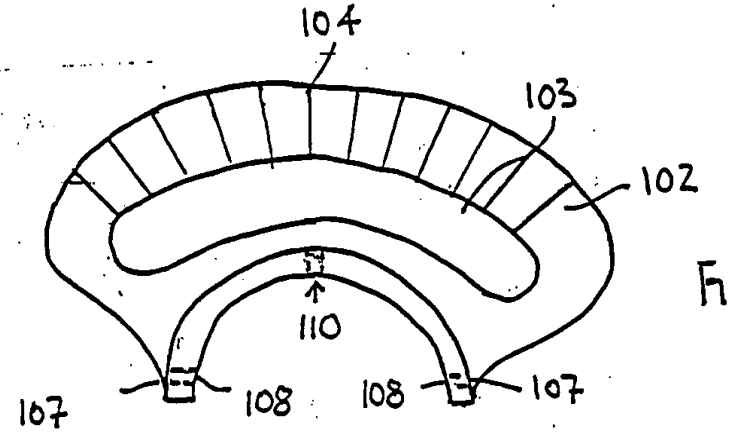


Fig 20